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(54) **METHOD AND APPARATUS FOR ACOUSTIC DETECTION AND LOCATION OF DEFECTS IN STRUCTURES OR ICE ON STRUCTURES**

(75) Inventors: **Dimitri M. Donskoy**; **Alexander M. Sutin**, both of Hoboken, NJ (US)

(73) Assignee: **The Trustees of the Stevens Institute of Technology**, Hoboken, NJ (US)

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(58) **Field of Search** ..... 73/579, 583, 584, 73/587, 590, 591, 592, 596, 597, 598, 599, 602; 244/134 R, 134 F

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Primary Examiner—Helen Kwok
(74) *Attorney, Agent, or Firm*—Wolff & Samson

(57) **ABSTRACT**

The invention relates to a method and apparatus for nondestructive testing and evaluation of materials and mechanical structures to determine their integrity reducing contact-type flaws such as cracks, fractures, delamination, unbondings, etc. and also presence of ice on a structure. The invention employs an ultrasonic probing signal and a low frequency vibration applied to a structure tested. In a structure without flaws or ice, these signals propagate independently without any interaction. If the structure contains a defect or ice thereon, the vibration varies the contact area of the defect or ice/structure interface, modulating the phase and amplitude of the higher frequency ultrasonic probing signal passing through the structure. In the frequency domain the result of this modulation manifests itself as sideband spectral components with respect to frequency of the probe wave. This can be considered as a new signal generated by a defect, so that the defect can be detected more easily when such a signal is observed. There are three modes of detection including, vibro-modulation, impact-modulation and self-modulation. The location of defects can be determined in two modes. In a first mode defect is located by moving the low frequency signal about the structure and triggering the high frequency signal immediately after the low frequency signal. Defects can be located in a second mode with a sequence of short burst high frequency signal and a signal-processing algorithm which selects the sequences reflected from various areas of the tested structure. A defect can be quantitatively analyzed by sweeping the high frequency signal over a defined frequency range and measuring, averaging and normalizing the amplitudes of the side bands.

39 Claims, 10 Drawing Sheets